A preliminary camera traps assessment of terrestrial vertebrates at different elevation gradients in Gunung Stong State Park....

Article *in* Malayan Nature Journal · March 2018

Kamarul Hambali
University of Malaysia, Kelantan

Aainaa Amir
University of Malaysia, Kelantan

Malayan Nature Journal 2018, 70(1), 3-11

A preliminary camera traps assessment of terrestrial vertebrates at different elevation gradients in Gunung Stong State Park, Kelantan, Malaysia

LO SHEA LING[1], NIK MOHD MASERI[1], KAMARUL HAMBALI[1],* and AAINAA AMIR[1]

Abstract: As a preliminary mean of verifying their presence, composition and possible distribution of terrestrial wildlife, camera trapping was conducted within the Gunung Stong State Park. Seven camera traps were placed at 7 different locations at different altitudes. They were placed for 2 months and 83 images were captured with 10 species identified. The most frequently photographed during the 63 day period were the wild boar (*Sus scrofa*), red muntjac (*Muntiacus muntjak*), plantain squirrel (*Callosciurus caniceps*), leopard cat (*Pardofelis marmorata*), binturong (*Arctictis binturong*), Malayan sunbear (*Heliarctos malayanus*), Malayan tapir (*Tapirus indicus*), serow (*Capricornis sumatraensis*), Malayan pangolin (*Manis javanica*) and Malaysian field rat (*Rattus tiomanicus*). The largest number of images recorded was at Point 3 (468.5m), with 35 out of 83 images, near a camp site frequented by hikers. The results are preliminary, but can be used as a baseline data for subsequent studies that could help in the management of Gunung Stong State Park.

Key words: terrestrial vertebrates, camera trapping, altitudinal elevations, Gunung Stong State Park.

INTRODUCTION

The tropical rainforest is high in species richness and diversity compared with other biomes (Baltzer and Thomas, 2002). This is due to the abundance of rainfall that allows forest trees to stay green all the year to support a rich flora and fauna and a level of biological production that is greater than any other natural ecosystems in the world (Drinnen, 2000). Gunung Stong State Park (GSSP) is a protected area managed by the Kelantan Forestry Department. On the route to the summit (1422m) of Gunung Stong, one encounters dense forest, mountain streams and a rock-shelter (Mariana et al., 2005). The Gunung Stong waterfalls, at 492m above sea level is believed to be among the highest waterfall in Southeast Asia (Mariana et al., 2005). The presence of several habitat types, physical attractions like waterfalls and mountain-streams, which are popular among mountain recreationists, and home to diverse wildlife and plants make GSSP a unique area (Maseri, 2009). This is especially so, since mammals like elephants, tigers, bears, gibbons, and birds such as hornbills and a range of other exotic animals have been sighted, and endemic plants like the small bamboo (*Holtummochloa pubescens*), and the fan-palm (*Licuala stongensis*), have been recorded here (Maseri, 2009). GSSP had been selectively logged in the late 1980s, the forest is now re-generating (Maseri, 2009). Human activity impacts result in decreased mammalian species richness (Woodroffe, 2000), and the steady increase in human populations has adversely affect mammalian populations due to human-wildlife conflicts, poaching and encroachments into wilderness areas (Hayward et al., 2005). As habitats decrease, the need to create reserves to conserve and preserve mammalian species become essential, and one effective method is through conserving the remaining areas of high species richness (Myers et al., 2000). In other words, species richness acts as the indicator of conservation value (Meir et al., 2004). Therefore, to perform effective conservation management in protected areas, understanding the diversity and species richness is an important step, and that is the main goal of this study: To obtain the assess

[1]Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia.
*Corresponding author: kamarul@umk.edu.my

species richness and diversity of mammals across elevation gradients in GSSP. Research has shown that species changes along elevation gradients and are very important for identifying the main future needs of conservation of species (Fischer et al., 2011), and knowledge of the species and communities that occur within the protected area, and understanding the connection of habitats and habitat disturbances, are essential for biodiversity conservation at landscape scales (Parrish et al., 2003; Zipkin et al., 2010).

MATERIALS AND METHOD

Study area

This study was carried out in GSSP (Figure 1), a 21,950 ha protected area managed by the Forestry Department Kelantan, located in the Dabong sub-district, Kuala Krai (Maseri and Mohd-Ros, 2005). Due to its scenic waterfalls, beautiful scenery, biodiversity and mountain summits, it is a popular nature destination for hikers, who also visit the Dabong caves as part of their activities. GSSP is strategically positioned between the Gunung Stong Selatan Forest Reserve (18,134 ha), the Balah Forest Reserve (56,010 ha), Gunung Stong Utara Forest Reserve (11,044 ha), Basor Forest Reserve (40,790 ha), and the Berangkat Forest Reserve (21,409 ha).

Sampling technique

Seven cameras were placed at different altitudes along the existing hikers trail to the summit of Gunung Stong, and at the strategic locations. The altitudes where the cameras were placed range from 297.3m to 1420m, with habitats ranging from lowland dipterocarp to montane ericaceous forests. The date, time and location were marked by the GPS, and the cameras were retrieved in 63 days, and the images collected for further analysis and documentation. Francis (2008) was used to identify each captured individual mammal.

Statistical analysis

Shannon-Wiener Diversity Index was used to determine the diversity index. Even though there are other indices that can be used, we selected this index because of its simplicity (Krebs, 2014). The equation used for the calculation is:

$$H = -sum\ (pi\ ln\ [pi])$$

Where pi is the number of individuals of a species over the total number of individuals overall.

Figure 1. Map of the study area (Source: WWF-Malaysia, 2009).

RESULTS AND DISCUSSION

At the end of the 63-day survey period, photographs were arranged by individual site locations. Station 3 (N5˚20'26.00", E101˚58'01.06") and Station 6 (N5˚20'10.06", E101˚56'43.00") were removed because the cameras were stolen. As a result of removing these two sites, all analyses were calculated using the remaining 5 Stations. Photographs were examined to identify individual species. Data at each site were examined and species lists were compiled for each camera location (Table 1). The total number of species was calculated for each camera site.

Throughout the 63-day sampling survey a total of 12 mammalian species and 83 individuals (Table 1) were detected in GSSP. These detections included small, large and medium carnivores, herbivores and omnivores. Across the elevation gradient, there were different species and frequencies recorded. The 12 mammalian species that were captured include two unidentified species, *Helarctos malayanus* (1), *Pardofelis marmorata* (4), *Tapirus indicus* (1), *Sus scrofa* (39), *Muntiacus muntjak* (9), *Arctictis binturong* (3), *Capricornis sumatraensis* (1), *Rattus tiomanicus* (17), *Manis javanica* (1) and *Callosciurus caniceps* (5). In term of conservation status, one was categorised as critically endangered species (*Manis javanica*), one endangered (*Tapirus indicus*), three vulnerable species (*Helarctos malayanus*, *Artictis binturong* and *Capricornis sumatraensis*), one near threatened (*Pardofelis marmorata*) and the rest are listed as least concerned (*Sus scrofa, Muntiacus muntjak*, *Rattus tiomanicus* and *Callosciurus caniceps*) by the IUCN Red List of threatened species.

From Table 1 the highest number of species is located at point 3 (468.5m) which has about 10 species consisting of 35 individuals detected. While, at the elevation of 1420m (point 5) only two species were detected which has the lowest number of species compared to the other 4 points. The patterns of mammal species richness along elevation gradient GSSP is shown in Figure 2.

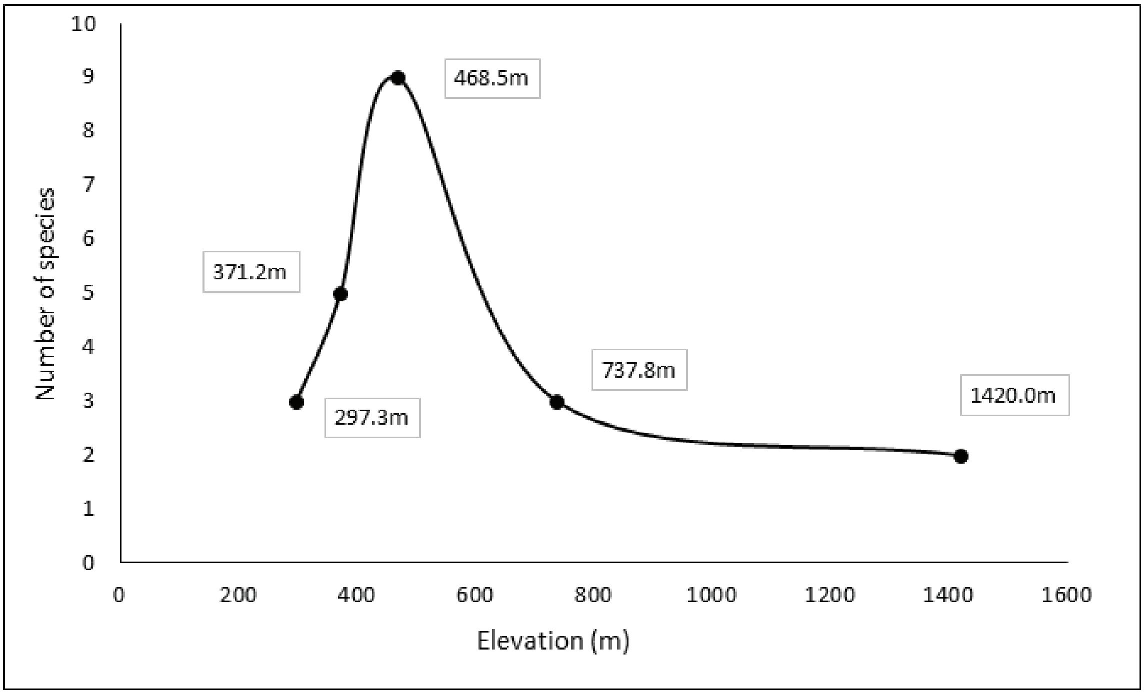

Figure 2. Number of species against elevation.

There is a significant increase in the trend of total species richness from 297.3m to 468.5m but from 468.5m to 1420m, there is a clear decrease. Thus, the high mammal species richness in GSSP peaked at the middle elevation of 468.5m. This value accounts for 75% of the total number of mammal species detected by the camera traps. This is also similarly proven by the rarefaction graph in Figure 3 that shows the Point 3 (468.5m) at mid-peak indicates a higher and longer curve in comparison to the other 4 points. In other words, point 3 stated at mid-elevation peak has a higher number of species than the other points.

Table 1. Checklist of mammalians species detected by using camera trap across the elevation gradient in Gunung Stong State Park.

Species	Point 1 (297.3m) N 05°20'28.06" E 101°58'17.52"	Point 2 (371.2m) N 05°20'33.06" E 101°58'16.00"	Point 3 (468.5m) N 05°28'26.00" E 101°58'01.06"	Point 4 (737.8m) N 05°20'25.03" E 101°57'29.09"	Point 5 (1420m) E 05°20'10.09" E 101°56'16.00"	Total	IUCN Status
Unidentified species	0	0	1	0	0	1	-
Helarctos malayanus	0	0	0	1	0	1	VU
Pardofelis marmorata	2	0	2	0	0	4	NT
Tapirus indicus	0	1	0	0	0	1	EN
Sus scrofa	10	13	15	5	0	43	LC
Muntiacus muntjak	3	1	2	3	0	9	LC
Arctictis binturong	0	1	1	0	1	3	VU
Unidentified species	0	0	1	0	0	1	-
Capricornis sumatraensis	0	0	1	0	0	1	VU
Rattus tiomanicus	0	7	10	0	0	17	LC
Manis javanica	0	0	1	0	0	1	CR
Callosciurus caniceps	0	0	1	0	4	5	LC
Total of individual	15	23	35	9	5	83	[redacted]
Numbers of species	3	5	10	3	2		
Trap-days	63	63	63	63	63		

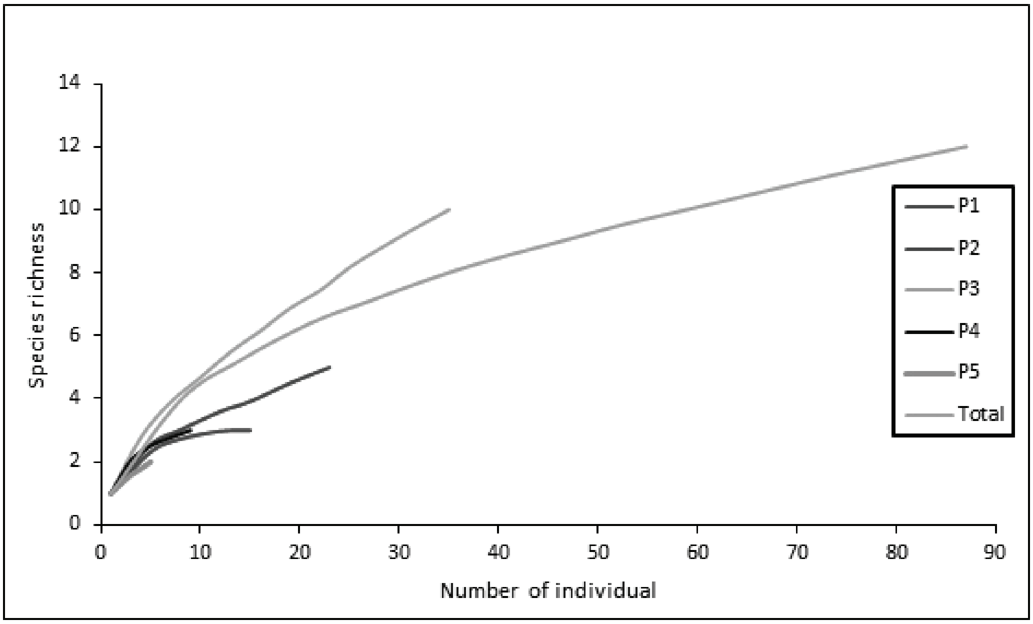

Figure 3. The rarefaction graph for species diversity at each elevation in GSSP.

The hump-shaped pattern of the species diversity along elevation gradient GSSP also can be shown by Shannon-Wiener diversity index (Table 2). The Shannon-Wiener diversity index from point 1 to point 3 showed a significant increase in species diversity, while species diversity decreases from point 3 to point 5. The pattern of the initial increase in species richness peaked at the higher elevation of 468.5 after which is seen a dip as the elevation increases beyond this point. This is similar to the study of the patterns of ant species richness along elevation gradients in an arid ecosystem in Spring Mountains, Nevada, U.S.A where the ant species richness across the elevation graphed is a hump-shaped (Sanders et al., 2003).

Table 2. Shannon-Wiener diversity index at each of elevation in GSSP.

Point	Shannon-Weiner diversity index, H
1	0.884
2	1.070
3	1.621
4	0.934
5	0.500

The distribution of species richness along elevation gradients is influenced by a series of interacting biological, geographical, energy, climatic and historical factors (Rahbek, 1995; Lomolino, 2001). Further, the environmental variables will change according to elevation and every elevation represents a complex gradient (Austin et al., 1996). This observed hump-shaped species richness patterns of mammals in GSSP is in accordance with habitat heterogeneity and optimum resource combination in the intermediate portion of the elevation gradient. The mid-elevation peak ranges with an optimal combination of environmental resource and provides more niches that are more preferable for many species to coexist (Lomolino 2001; Brown, 2001). Also the elevation of point 3 overlaps between low elevation and high elevation species (mixed community) and it has the greatest species richness compared to other 4 points. Such a trend of mixed habitats and resources in mid-elevation areas could be a partial reason for the high species richness of mammals at mid-elevations in GSSP.

Climatic patterns in the high elevation of the mountain might influence the species richness in GSSP. Hawkins et al. (2005) and Evans et al. (2005) stated that temperature was the most obvious evidence that prove climatic variations changes according to elevation patterns and every increase of elevation from 100m the temperature decrease by an average of approximately 0.68˚C (Barry, 2008). Elevation determines temperature and the decreasing temperatures from low elevation (297.3m) to the mountain peak in GSSP could be responsible for the low species count. While, point 3 has higher species compared to 297.3m and 371.2m and may be due to the temperature (environment condition) which is favourable for mammals to survive (Brown, 2001).

Grytnes and McCain (2010) stated the productivity is dependent on temperature and precipitation. Climate condition restricts the productivity, which in turn limits the population size and the total number of individuals (Brown, 2001). Thus, low temperature will decrease the primary productivity. Usually, the factor that has correlation with productivity is indicated by the more individual factors, which predicts that the positive relationship between diversity and productivity is due to the ability of high productive areas to support more individuals within a community and thus, more species (Srivastava and Lawton, 1998). Heferkamp (1988) indicated that temperature is essential for regulating rates of physiological process and influencing growth, development of plants and plant productivity. As some mammals are herbivores which rely on producers as the food source to sustain life, the production or growth of plants will give a big impact to the mammals. Many factors have been proposed to explain this variation food-chain length among natural communities, including productivity, disturbance, ecosystem size (area or volume), habitat heterogeneity, species richness, design and size constraints, optimal foraging, and the history of community organisation (Pimm, 1982; Post, 2002; Elton, 1927). Therefore the higher number of species at point 3 is possible due to the favorable temperature that supports the high productivity of mammals there. In addition, the interactions of several biological, physical and chemical factors could also affect the species richness at higher elevations.

The pattern of distribution is not permanent for each species. Distribution patterns can change seasonally, in response to the availability of resources, and other factors. Possibly, there is a link between the availability of resources and elevation at 468.5m. It does suggest that sites where food, water and shelter are available, they meet the basic requirements of mammals to survive. The site at 468.5m could explain the high presence of mammals based on this observation. Another possible factor is that the trip-camera was located near to the camp site of Camp Baha with similar lowland dipterocarps and streams features. This site is often used by visitors as a resting point (Maseri 2009) as well as an over-night campsite before attempting to scale the summit the following morning. Due to the frequent discarding of food-scraps by campers, the high presence of wildlife at site 3 could have been attracted to this source of food.

Habitat destruction typically leads to fragmentation, the division of habitat into smaller and more isolated fragments separated by human-transformed land cover (Ewers and Didham, 2006). Fragmentation not only causes loss of the amount of habitat, but by creating small, isolated patches it also changes the properties of the remaining habitats (van den Berg et al., 2001). When the original habitat is destroyed due to land use changes, resulting in fragmentation, wildlife seeks these remaining natural habitat sanctuaries (Virgos, 2001). Compressed into these smaller areas, there is greater intra- and inter-species competition and some may migrate to habitats usually not conducive to them. This could be the reason for the greater species richness in point 3, when their original habitats were in the lower altitudes. However, in this study, the 468.5m elevation has all the basic requirements for wildlife to survive compared to other elevations; therefore, wildlife that chooses to survive in the mountain will choose point 3 as their habitat because of richness of resources. In addition, wildlife that is captured in all the cameras may not necessarily be different individuals, but same individuals, as they search for food resources around the area.

CONCLUSION

As a conclusion, this study has provided new records of species richness and diversity of mammals across elevation gradient in GSSP by using the camera-trap technique. Half of the captured species was listed as least concerned (LC) in IUCN Red List of Threatened Species, while the other species are listed as critically endangered, endangered, vulnerable, near threatened. This information could aid in improving the management effectiveness of GSSP, a protected area under the Kelantan Forestry Department. The humped graph of species richness along the elevation gradient shows the species richness and diversity of mammals across the elevation gradient in GSSP which is caused by the factors of mid-domain effect and climate. However, these factors are not only ones that caused the abundant species at mid-elevation peak, it is also possible due to availability resources and forest fragmentation.

Acknowledgements: We would like to thank Forest Department Peninsular Malaysia, Kelantan for allowing us to conduct this study at Gunung Stong State Park, Jeli. Thanks also go to Ahmad Auzan bin Azhar and Saiful bin Sulaiman for field and technical assistance during this project.

REFERENCES

Austin, M.P., Pausas, J.G. and Nicholls, A.O. (1996). Patterns of tree species richness in relation to environment in south-eastern New South Wales, Australia. *Australia Journal of Ecology* 21 : 154-164.

Baltzer, L.J. and Thomas C.S. (2002). Tropical Forests. *Encyclopaedia of life sciences* pp. 1-8.

Barry, R.G. (2008). Mountain Weather and Climate. Cambridge, UK: Cambridge University Press.

Brown, J. (2001). Mammals on mountainsides: elevational patterns of diversity. *Global Ecology and Biogeography*10 : 101-109.

Drinnen, K. (2000). *Tropical rainforests. Chapter 3*: *Tropical rainforest plants*. (Eds. 3), pp. 25. Moody Gardens Balveston Island.

Elton, C. (1927) Animal ecology. Metapopulation models: the rescue effect, the propagule rain, and the core-satellite hypothesis. *American Naturalist* 138 : 768-776.

Evans, K.L., Warren, P. H. and Gaston, K.J. (2005) Species-energy relationships at the macroecological scale: a review of the mechanisms. *Biological Reviews* 80 : 1-25.

Ewers, R.M. and Didham, R.K. (2006). Confounding factors in the detection of species responses to habitat fragmentation. *Biological Reviews* 81: 117-142.

Fischer, A., Blaschke, M. and Bässler, C. (2011). Altitudinal gradients in biodiversity research: the state of the art and future perspectives under climate change aspects. Waldökologie, Landschaftsforschung und Naturschutz 11 : 35-47.

Francis, M.C. (2008). *A Guide To The Mammals OF Southeast Asia*. UK: New Hollan Publishers (UK) Ltd.

Grytnes, A.J. and McCain, M.C. (2010). Elevational gradients in species richness. *Encyclopedia of biodiversity* pp. 1-10.

Haferkamp, M.R. (1988). Environmental factors affecting plant productivity. In: White, R.S. & Short, R.E. (eds), *Achieving efficient use of rangeland resources*. Bozeman: Montana State University Agricultural Experiment Station. pp. 27-36.

Hawkins, B.A., Diniz-Filho, J.A.F. and Weis, E.A. (2005). The Mid-domain effect and diversity gradients: is there anything to learn? *The American naturalist* 5 : 140-143.

Hayward, M.W., White, R.M., Mabandla K.M. and Pakama P. (2005). Mammalian fauna of indigenous forest in the Transkei region of South Africa: an overdue survey. *South African Journal of Wildlife Research* 35(2) : 117-124.

Krebs, C.J. (2014). *Ecological Methodology*. (3. Ed). Retrieved 02/05/2016, from http://www.zoology.ubc.ca/~krebs/books.html.

Lomolino, M.V. (2001) Elevation gradients of species-density: historical and prospective views. *Global Ecology and Biogeography*10 : 3–13.

Manokaran, N. (1992). An overview of biodiversity in Malaysia. *Journal of Tropical Forest Science* 5(2) : 271-290.
Mariana, A., Zuraidawati, Z., Ho, T.M., MohdKulaimi, B., Saleh, I., Shukor, M.N. and Shahrul-Anuar, M.S. (2005). A survey of ecoparasites in gunungstong forest reserve, Kelantan, Malaysia.*Southeast Asia journal trop med public health* 5 : 1125-1132.
Maseri, N.M. and Mohd-Ros, A.H. (2005). Managing Gunung Stong State Park: A conceptual framework, pp. 31–43. In: Shaharudin M.I., T. Dahalan, S.S. Abdullah, M.S. Jalil, I. Faridah-Hanum& A. Latiff (eds.). *Taman Negeri Gunung Stong, Kelantan: Pengurusan, Persekitaran Fizikal, Biologi dan Sosio-Ekonomi*. Siri Kepelbagaian Biologi Hutan 5 : 31-43. Jabatan Perhutanan Semenanjung Malaysia.
Maseri, N.M. (2009). *Gunung Stong State Forest Park*: A Guidebook. Sasyaz Holdings Sdn. Bhd, Petaling Jaya, Malaysia.
Meir, E., Andelman, S., and Possingham, H.P. (2004). Does conservation planning matter in a dynamic and uncertain world? *Ecology Letter* 7 : 615–622.
Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonesca, G.A.B. and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403 : 853–858.
Parrish, D.J., Braun, P.D. and Unnasch, S.R. (2003). Are we conserving what we are? Measuring Ecological Integrity within protected area. *Bioscience* 9 : 851-860.
Pimm, S.L. (1982). *Food webs*. Chapman and Hall, London.
Post, D.M. (2002).The long and short of food-chain length. *Trends in Ecology and Evolution* 17 : 269–277.
Rahbek, C. (1995). The elevational gradient of species richness - a uniform pattern. *Ecography* 18 : 200–205.
Sanders, N.J., Moss, J. and Wagner, D. (2003). Patterns of ant species richness along elevational gradients in an arid ecosystem. Global *Ecology and Biogeography* 10 : 77-100.
Srivastava, D.S. and Lawton, J.H. (1998). Why more productive sites have more species: an experimental test of theory using tree-hole communities. *American Naturalist* 152 : 510-529.
van den Berg, L.J.L., Bullock, J.M., Clarke, R.T., Langston, R.H.W. and Rose, R.J. (2001). Territory selection by the Dartford Warbler (*Sylvia undata*) in Dorset, England: the role of vegetation type, habitat fragmentation and population size. *Biological Conservation* 101 : 217-228.
Virgos, E. (2001). Role of isolation and habitat quality in shaping species abundance: a test with badgers (*Meles meles* L.) in a gradient of forest fragmentation. *Journal of Biogeography* 28 : 381-389.
Woodroffe, R. (2000). Predators and people: Using human densities to interpret declines of large carnivores. *Animal Conservation* 3 : 165-173.
WWF-Malaysia. (2009). Gunung Stong State Park: Final Base map. Retrieved 23/05/2016. from:http://www.wwf.org.my/about_wwf/what_we_do/forests_main/forest_protect/protect_projects/stong/
Zipkin, E.F., Royle, J.A., Dawson, D.K. and Bates, S. (2010). Multi-species occurrence models to evaluate the effects of conservation and management actions. *Biology Conservation* 143 : 479-484.